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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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PITTSBURGH, PA 15219

EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 01/30/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Applicati n No.

09/583,386

Applicant(s)

CARLEY, L. RICHARD

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 17 November 2001.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-4 and 21-23 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-4 and 21-23 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

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## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

1. Claim 23 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Applicant does not appear to have support from the specification to support the limitation that the structural material is self-passivating.

### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-2, 4, and 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art (APA) in view of Yao (US 5,578,976).

Applicant's APA clearly discloses that it is known to fabricate a microstructure in a sealed cavity comprising providing a substrate, one or more sacrificial layers, structural layers, first seal (encapsulating) layer with holes to provide flow of liquid etchant for removing sacrificial material, and sealing off the holes by depositing another seal layer over the holes. (See specification, pp. 1-2). It is held, absent evidence to the contrary, that the etch rate differential between the structural material, protective layers and/or substrate relative to the sacrificial material for any etchant used to remove the sacrificial material is inherently high, here and in *all*

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MEMS fabrication, in order to prevent the MEMS from being etched away. There is simply no reason to use an etchant that would significantly remove the structure being formed, in stark contradiction to the ability to form said structure.

Applicant's APA does not teach using a "non-liquid etchant" and a barrel etcher as the means to remove the sacrificial layers.

**Yao** teaches a method of forming a MEMS comprising providing a substrate 12, sacrificial layers of photoresist 30, 38 (called "polyimide" in **Yao**; Figs. 5A-6E) which secure the MEMS to the substrate until etched away, and structural material of aluminum 22, 24. **Yao** also discloses that it is especially beneficial to use a barrel etcher with an oxygen plasma to remove the sacrificial layers in order to circumvent problems associated with surface tension created by wet etching. (See **Yao**, col. 5, lines 41-65 and especially col. 6, lines 6-13.) Note that Applicant indicates the objective of the instant invention is to overcome the problems of surface tension by using a "non-liquid etchant" for at least the removal of the last sacrificial layer (specification, p. 3, ll. 10-24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the barrel etcher and oxygen plasma to remove the sacrificial layers of polyimide (i.e. photoresist) from the aluminum structural material for the reasons indicated in **Yao**, which are incidentally the same as Applicant's reasons.

Regarding claim 23, although Applicant does not appear to have provided support for the structural material being self-passivating in the environment of the etchant. It is notoriously well known that aluminum self-passivates, even in ambient air to form refractory aluminum oxide that prevents further oxidation because ambient oxygen cannot diffuse through the dense aluminum

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oxide surface layer. It is also noted that Applicants indicated in the section entitled "REMARKS" in responding to the first Office action, that aluminum is the preferred structural material and photoresist is the preferred sacrificial material (as in Yao). It is therefore held, absent evidence to the contrary, that aluminum is self-passivating.

4. Claims 1-2, 4-12, 15, 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art (APA) in view of **Hornbeck** (US 5,083,857).

Applicant's APA is applied as above.

Applicant's APA does not teach using a "non-liquid etchant."

**Hornbeck** teaches a method of fabricating a MEMS on a prefabricated CMOS silicon substrate 503 wherein each of the sacrificial layers 701, 705 is formed of photoresist and the structural layers 703, 704, 200 are formed of aluminum and the photoresist is removed using dry oxygen plasma etch. (See Figs. 7a-7d; col. 3, l. 54 to col. 4, l. 52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a non-liquid etchant for the reasons indicated in **Hornbeck**, and at least because the method in **Hornbeck** is indicated to be compatible with CMOS substrates and processing.

Regarding claim 4, although **Hornbeck** does not indicate that the plasma is oxygen plasma, Examiner gives official notice that it is notoriously well known to use oxygen plasma to remove photoresist. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use oxygen plasma as the plasma in **Hornbeck** because it is standard practice in the art to remove photoresist using oxygen plasma.

5. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's **APA** in view of **Yao** as applied to claims 1-2, 4, and 21-23 above, and further in view of **Muller et al.** (US 5,493,177).

The prior art as explained above discloses all of the limitations of claims except for using silicon nitride on the silicon substrate.

**Muller** teaches a method of fabricating a MEMS wherein silicon nitride 178 on a silicon wafer is used. (See col. 9, ll. 23-30.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the **Muller** silicon nitride layer of the substrate because Applicant admits (specification, p. 2) that Muller is known prior art and that Muller uses a protective layer on the silicon substrate and Muller indicates that this layer is silicon nitride, as noted above.

### *Conclusion*

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Note that **Core et al.** US 5,314,572 and **Hornbeck** US 5,083,857 are still considered relevant to the instant invention and may be re-introduced in the rejections depending upon future amendments by Applicant's which may re-introduce limitations removed in the present Amendment (Paper No.7, filed 11/16/01).

**Montague et al.** (US 5,798,283) discloses a sealed-cavity MEMS fabrication method using plural sacrificial layers, plural structural layers, seal layers, holes for etchant, and liquid etchant (See Figs).

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**Offenberg** (US 5,683,591) discloses a MEMS fabrication method using two different etchants wherein wet etching is used to remove silicate and oxygen plasma etch is used to remove photoresist (col. 3, l. 40 to col. 4, l. 3).

**Cole et al.** (US 6,238,580 B1) discloses a MEMS fabrication method using wet and vapor phase etching to remove sacrificial layers (cover figure).

The article to **Storment, et al.** entitled, "Flexible dry-released process for aluminum electrostatic actuators," Journal of Microelectromechanical Systems, 3(3), 9/1994, IEEE, pp. 90-96 discloses the instant invention except for the second sealing layer.

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.


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Any inquiry concerning this communication from examiner should be directed to Erik Kielin whose telephone number is (703) 306-5980 and e-mail address is erik.kielin@uspto.gov. The examiner can normally be reached by telephone on Monday through Thursday 9:00 AM until 7:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Albert Paladini, can be reached at (703)308-2005 or by e-mail at albert.paladini@uspto.gov. The fax phone number for the group is (703) 308-7722 or -7724.

  
EK

January 14, 2002

  
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